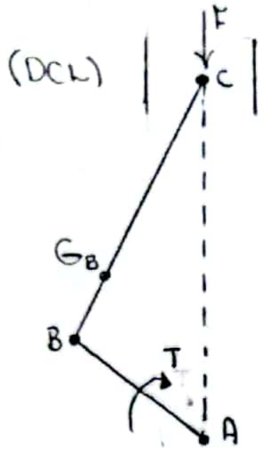
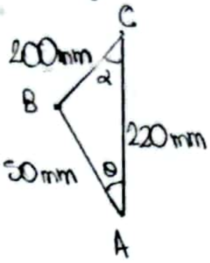
Prática 1 - Thallys Oliveira - 11319327



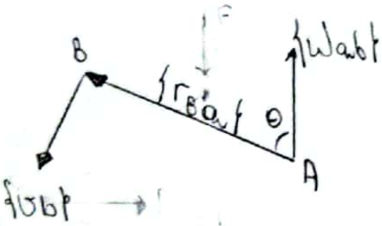
Dados: $AB = 50\ mm$, $BC = 200\ mm$, $CA = 220\ mm$; $BG_B = 70\ mm$;
$m_{AB} = 0,9\ kg$; $m_{BC} = 1,4\ kg$, $m_C = 1,0\ kg$; $A_{GA} = 0\ mm$
$I_G^{AB} = 0,006\ kg\ m^2$; $I_G^{BC} = 0,001\ kg\ m^2$; $I_G^{C} = 0,005\ kg\ m^2$
$\omega_{AB} = 250\ rad\ s^{-1}$ (anti-horário), $\alpha_{AB} = 50\ rad\ s^{-2}$; $T = 10\ N.m$

* Ângulo θ:



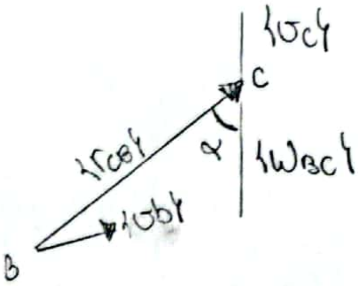
$\cdot\ 200^2 = 220^2 + 50^2 - 2.220.50.\cos\theta \Rightarrow \cos\theta = 0,4954 \therefore \theta = 60,3$
$\cdot\ 50^2 = 200^2 + 220^2 - 2.200.220.\cos\alpha \Rightarrow \cos\alpha = 0,9761 \therefore \alpha = 12,59°$

* Analisando a manivela: $\{v_b\} = \{\omega_{ab}\} \times \{r_{BA}\} \Rightarrow \begin{cases} \cdot\ \{\omega_{AB}\} = 250\hat{k} \\ \cdot\ \{r_{BA}\} = -50.\sin\theta\,\hat{i} + 50.\cos\hat{j} \end{cases}$



$\{v_b\} = (250\hat{k}) \times (-50\sin\theta\,\hat{i} + 50.\cos\hat{j})$
$\{v_b\} = (-10857,5\hat{j} - 6192,5\hat{i})\ mm/s$
$\{v_b\} = (-6,1925\hat{i} - 10,8575\hat{j})\ m/s$

* Analisando a biela: $\{v_c\} = \{v_B\} + \{v_{CB}\} \rightarrow \{\omega_{BC}\} \times \{r_{CB}\}$



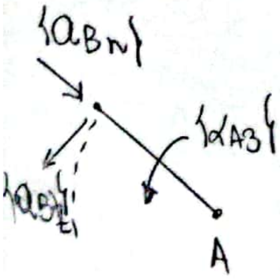
$\begin{cases} \cdot\ \{\omega_{BC}\} = -\omega_{BC}\hat{k} \\ \{r_{CB}\} = 200.\sin\alpha\,\hat{i} + 200\cos\alpha\,\hat{j} = 43,42\hat{i} + 195,23\hat{j} \end{cases}$

$\{v_{CB}\} = (-\omega_{BC}\hat{k}) \times (43,42\hat{i} + 195,23\hat{j})$
$\{v_{CB}\} = (-43,42.\omega_{BC}\hat{j} + 195,23.\omega_{BC}\hat{i})\ mm/s$

$\{v_c\} = -v_c\hat{j} = (-10857,5\hat{j} - 6192,5\hat{i}) + (-43,42.\omega_{BC}.\hat{j} + 195,23\,\omega_{BC}\,\hat{i})$
$-v_c\hat{j} = (-10857,5 - 43,42.\omega_{bc})\hat{j} + (-6192,5 + 195,23.\omega_{BC})\hat{i}$

$\begin{cases} -6192,5 + 195,23.\omega_{BC} = 0 \rightarrow \omega_{BC} = 31,72\ rad/s \\ -10857,5 - 43,42.\omega_{BC} = -v_c \rightarrow v_c = 12234,8\ mm/s \therefore v_c = 12,23\ m/s \end{cases}$

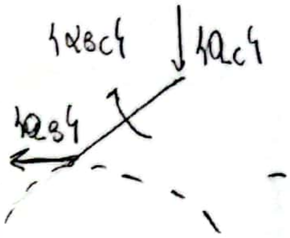
* Manivela: $\{a_B\} = \{a_A\} + \underbrace{\{\alpha_{AB}\} \times \{r_{BA}\}}_{\{a_{Bn}\}} + \underbrace{\{\omega_{AB}\} \times (\{\omega_{AB}\} \times \{r_{BA}\})}_{\{a_{Bt}\}}$



$\{a_B\} = (50\hat{k}).(-43,43 + 24,77\hat{j}) + (250\hat{k}) \times ((250\hat{k}) \times (-43,43\hat{i} + 24,77\hat{j}))$
$\{a_B\} = -2171,5\hat{j} - 1238,5\hat{i} + (250\hat{k}) \times (-10875,5\hat{j} - 6192,3\hat{i})$
$\{a_B\} = -2171,5\hat{j} - 1238,5\hat{i} + 2714375\hat{i} - 1548125\hat{j}$
$\{a_B\} = (2713136,5\hat{i} - 1550296,5\hat{j})\ mm/s^2$

$\{a_B\} = (2713,1365\,\hat{i} - 1550,2965)\ m/s^2$

Biela: $\{a_C\} = \{a_B\} + \{\alpha_{BC}\}\times\{r_{BC}\} + \{\omega_{BC}\}\times(\{\omega_{BC}\}\times\{r_{CB}\})$



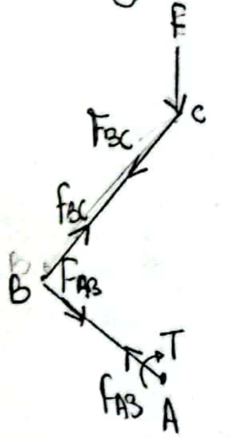
$\{a_C\} = (2713136,5\,\hat{i} - 1550296,5\,\hat{j}) + (\alpha_{BC}\hat{k})\times(43,42\,\hat{i} + 185,23\,\hat{j}) + (-31,72\,\hat{k})\times((-31,72\,\hat{k})\times(43,42\,\hat{i} + 185,23\,\hat{j}))$

$-a_C\hat{j} = (2668449,1023 + 185,23\cdot\alpha_{BC})\hat{i} + (1746729,8049 - 43,42\,\alpha_{BC}\,\hat{j})$

$$\begin{cases} 2668449,1023 + 185,23\cdot\alpha_{BC} = 0 \rightarrow \alpha_{BC} = -13673,355\ rad/s^2 \\ -174672,8044 - 43,42\cdot\alpha_{BC} = -a_C \rightarrow a_C = 1153037,73\ mm/s^2 \end{cases}$$

$a_C = 1153,03\ m/s^2$

· Diagrama de forças:



· Manivela: $T_A = T + T_{BC}$ $\quad \{r_{AB}\}\times\{F_{BC}\} = \{r_{AB}\}\times\left[|F_{BC}|\cdot\frac{\{r_{CB}\}}{|r_{CB}|}\right] \Rightarrow$

$T_{BC} = (-43,43\,\hat{i} - 24,77\,\hat{j})\times|F_{BC}|\cdot\left(\frac{43,42\,\hat{i} + 185,23\,\hat{j}}{200}\right)$

$T_{BC} = |F_{BC}|\cdot(42,39 + 5,38)\hat{k} \Rightarrow T_{BC} = 47,77\cdot|F_{BC}|\ N\cdot mm$ ∴

$T_{BC} = 0,0478\cdot|F_{BC}|\ N\cdot m$

$T_A = T + T_{BC} \Rightarrow I_G^{AB}\cdot\alpha_{AB} = -10 + 0,0478\cdot|F_{BC}| \Rightarrow$

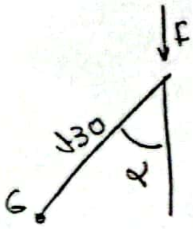
$I_G^{AB}\cdot\alpha_{AB} = -10 + 0,0478\cdot|F_{BC}| \Rightarrow 0,006\cdot 50 = -10 + 0,0478\cdot|F_{BC}|$ ∴ $|F_{BC}| = 215,48\,N$

, Pistão: $F_C = F - F_{BC}\cdot\cos\alpha = m_C\cdot a_C \Rightarrow F = -215,48\cdot\cos(12,54°)$ ∴

$F = 1363,37\,N$

. Biela: $T_C = T_F + T_{AB} \Rightarrow$

* $|T_F| = F\cdot d = F\cdot 130\cdot\sin\alpha = 1363,37\cdot 130\cdot\sin(12,54°) \Rightarrow$



$|T_F| = 38481,34\ N\cdot mm$ ∴ $\{T_F\} = (-38,48\,\hat{k})\ N\cdot m$

* $T_{AB} = \{r_{GB}\}\times\{F_{AB}\} = \{r_{GB}\}\times\left(|F_{AB}|\cdot\frac{\{r_{BA}\}}{|r_{BA}|}\right) \Rightarrow$

$T_{AB} = (-15,2\,\hat{i} - 68,33\,\hat{j})\times\left(\frac{|F_{AB}|\cdot(-43,43\,\hat{i} + 24,77\,\hat{j})}{30}\right)$

$T_{AB} = (-15,2\hat{i} - 68,33\hat{j}) \times (|F_{AB}| \cdot (-0,868\hat{i} + 0,495\hat{j})) \Rightarrow T_{AB} = 66,302 \cdot |F_{AB}|\, N.mm$

$\therefore T_{AB} = 0,0663 \cdot |F_{AB}|\, N.m$

$T_C = J_G^{BC} \cdot \alpha_{BC} = -38,48 + 0,0663 \cdot |F_{AB}| \Rightarrow 0,00113673355 = -38,48 + 0,0663 \cdot |F_{AB}|$

$|F_{AB}| = 779,57 N$

Assim, com os resultados obtidos, concluímos:

a) $\{v_C\} = -12,23\hat{j}$ m/s b) $\{a_C\} = -1153,03\hat{j}$ m/s c) $\{F\} = -1363,37\hat{j}$ N

d) $T_{BC} = |F_{BC}| \cdot 0,0478 = 215,48 \cdot 0,0478 \therefore T_{BC} = 10,3$ N.m

e) $\{F_A\} = \{F_{AB}\} = |F_{AB}| \cdot \frac{\{r_{BA}\}}{|r_{BA}|} = 779,57 \cdot (-0,0868\hat{i} + 0,495\hat{i}) \therefore$

$\{F_A\} = (-677,45\hat{i} + 385,89\hat{j})\, N \therefore F_A = 779,65 N$

f) $\{F_B\} = \{F_{BC}\} + \{F_{AB}\} = 215,48 \cdot (0,217\hat{i} + 0,976\hat{j}) + (-677,45\hat{i} + 385\hat{j})$

$\{F_B\} = (-630,67\hat{i} + 595,31\hat{j})\, N \therefore F_B = 867,26 N$

g) $\{F_C\} = \{F\} + \{F_{BC}\} = (-1363,37\hat{j}) + 215,48 \cdot (0,2171\hat{i} + 0,976\hat{j}) \therefore$

$\{F_C\} = (46,78\hat{i} - 1153,06\hat{j})\, N \therefore F_C = 1154 N.$